

# 2N2904, 2N2904A, 2N2904AL 2N2905, 2N2905A, 2N2905AL

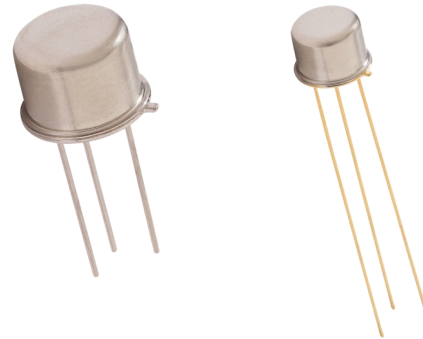


## Radiation Hardened PNP Silicon Switching Transistors

Rev. V3

### Features

- Qualified to MIL-PRF-19500/290
- Available in JAN, JANTX, JANTXV, JANS and JANSR
- Radiation Tolerant Levels M, D, P, L and R
- TO-39 and TO-5 package styles
- General Purpose Switching and Amplifier Applications



### Electrical Specifications @ $T_A = 25^\circ\text{C}$

Parameter	Test Conditions	Symbol	Units	Minimum	Maximum
<b>Off Characteristics:</b>					
Collector - Emitter Breakdown	$I_C = -10 \text{ mA dc}$ 2N2904, 2N2905 2N2904A, 2N2905A 2N2904AL, 2N2905AL	$V_{(BR)CEO}$	V dc	-40 -60 -60	—
Collector - Base Cutoff Current	$V_{CB} = -60 \text{ V dc}$	$I_{CBO1}$	$\mu\text{A dc}$	—	-10
Collector - Base Cutoff Current	$V_{CB} = -50 \text{ V dc}$ 2N2904, 2N2905 2N2904A, 2N2905A 2N2904AL, 2N2905AL	$I_{CBO2}$	nA dc	—	-20 -10 -10
Emitter - Base Cutoff Current	$V_{EB} = -5.0 \text{ V dc}$	$I_{EBO1}$	$\mu\text{A dc}$	—	-10
Emitter - Base Cutoff Current	$V_{EB} = -3.5 \text{ V dc}$	$I_{EBO2}$	nA dc	—	-50
Collector-Emitter Cutoff Current	2N2904, 2N2905; $V_{CE} = -40\text{V dc}$ 2N2904A, 2N2904AL; $V_{CE} = -60\text{V dc}$ 2N2905A, 2N2905AL; $V_{CE} = -60\text{V dc}$	$I_{CES}$	$\mu\text{A dc}$		1 1 1

1. Pulse Test: Pulse Width = 300 us, Duty Cycle < 2%.

(Continued next page)

VPT Components and its affiliates reserve the right to make changes to the product(s) or information contained herein without notice.  
Visit [www.vptcomponents.com](http://www.vptcomponents.com) for additional data sheets and product information.

For further information and support please visit:  
[info@vptcomponents.com](mailto:info@vptcomponents.com)

# 2N2904, 2N2904A, 2N2904AL 2N2905, 2N2905A, 2N2905AL



## Radiation Hardened PNP Silicon Switching Transistors

Rev. V3

Parameter	Test Conditions	Symbol	Units	Minimum	Maximum
<b>On Characteristics:</b>					
Forward Current Transfer Ratio	$V_{CE} = -10 \text{ V dc}$ , $I_C = -0.1 \text{ mA dc}$ 2N2904 2N2905 2N2904A, 2N2904AL 2N2905A, 2N2905AL	$h_{FE1}$		20 35 40 75	
Forward Current Transfer Ratio	$V_{CE} = -10 \text{ V dc}$ , $I_C = -1.0 \text{ mA dc}$ 2N2904 2N2905 2N2904A, 2N2904AL 2N2905A, 2N2905AL	$h_{FE2}$		25 50 40 100	175 450 175 450
Forward Current Transfer Ratio	$V_{CE} = -10 \text{ V dc}$ , $I_C = -10 \text{ mA dc}$ 2N2904 2N2905 2N2904A, 2N2904AL 2N2905A, 2N2905AL	$h_{FE3}$		35 75 40 100	
Forward Current Transfer Ratio	$V_{CE} = -10 \text{ V dc}$ , $I_C = -150 \text{ mA dc}$ 2N2904 2N2905 2N2904A, 2N2904AL 2N2905A, 2N2905AL	$h_{FE4}$		40 40 100 100	120 120 300 300
Forward Current Transfer Ratio	$V_{CE} = -10 \text{ V dc}$ , $I_C = -500 \text{ mA dc}$ 2N2904 2N2905 2N2904A, 2N2904AL 2N2905A, 2N2905AL	$h_{FE5}$		20 30 40 50	
Collector - Emitter Voltage (Saturated)	$I_C = -150 \text{ mA dc}$ , $I_B = -15 \text{ mA dc}$ $I_C = -500 \text{ mA dc}$ , $I_B = -50 \text{ mA dc}$	$V_{CE(sat)1}$ $V_{CE(sat)2}$	Vdc	—	-0.4 -1.6
Base - Emitter Voltage (Saturated)	$I_C = -150 \text{ mA dc}$ , $I_B = -15 \text{ mA dc}$ $I_C = -500 \text{ mA dc}$ , $I_B = -50 \text{ mA dc}$	$V_{BE(sat)1}$ $V_{BE(sat)2}$	Vdc	—	-1.3 -2.6

# 2N2904, 2N2904A, 2N2904AL 2N2905, 2N2905A, 2N2905AL



## Radiation Hardened PNP Silicon Switching Transistors

Rev. V3

### Electrical Specifications ( $T_A = 25^\circ\text{C}$ unless otherwise specified)

Parameter	Test Conditions	Symbol	Units	Minimum	Maximum
Collector-Base Cutoff Current	$T_A = +150^\circ\text{C}$ $V_{CB} = -50\text{ V dc}$ 2N2904, 2N2905 2N2904A, 2N2904AL 2N2905A, 2N2905AL	$I_{CBO3}$	$\mu\text{A dc}$		-20 -10 -10
Small-Signal Short-Circuit, Forward Current Transfer Ratio	$T_A = -55^\circ\text{C}$ $V_{CE} = -10\text{ V dc}$ , $I_C = -1.0\text{ mA dc}$ 2N2904 2N2905 2N2904A, 2N2904AL 2N2905A, 2N2905AL	$h_{fe6}$		15 30 20 50	—
Parameter	Test Conditions	Symbol	Units	Minimum	Maximum
<b>Dynamic Characteristics:</b>					
Small-Signal Short-Circuit Forward Current Transfer Ratio	$V_{CE} = -20\text{ V dc}$ , $I_C = -50\text{ mA dc}$ , $f = 100\text{ MHz}$	$ h_{fe} $		2.0	
Small-Signal Short-Circuit, Forward Current Transfer Ratio	$V_{CE} = -10\text{ V dc}$ , $I_C = -1\text{ mA dc}$ , $f = 1\text{ kHz}$ 2N2904 2N2905 2N2904A, 2N2904AL 2N2905A, 2N2905AL	$h_{fe}$		25 50 40 100	—
Open Circuit Output Capacitance	$V_{CB} = -10\text{ V dc}$ , $I_E = 0$ , $100\text{ kHz} \leq f \leq 1\text{ MHz}$	$C_{obo}$	$\mu\text{F}$	—	8
Input Capacitance (Output Open-circuited)	$V_{EB} = -2.0\text{ V dc}$ , $I_C = 0$ , $100\text{ kHz} \leq f \leq 1\text{ MHz}$	$C_{ibo}$			30
<b>Switching Characteristics:</b>					
Turn-On Time	(See figure 6 of MIL-PRF-19500/291)	$t_{on}$	ns	—	45
Turn-Off Time	(See Figure 7 of MIL-PRF-19500/291)	$t_{on}$	ns	—	300

# 2N2904, 2N2904A, 2N2904AL 2N2905, 2N2905A, 2N2905AL



## Radiation Hardened PNP Silicon Switching Transistors

Rev. V3

### Absolute Maximum Ratings ( $T_A = 25^\circ\text{C}$ unless otherwise specified)

Ratings	Symbol	Value
Collector - Emitter Voltage 2N2904, 2N2905 2N2904A, L; 2N2905A, L	$V_{CEO}$	-40 V dc -60 V dc
Collector - Base Voltage	$V_{CBO}$	-60 V dc
Emitter - Base Voltage	$V_{EBO}$	-5.0 V dc
Collector Current	$I_C$	-600 mA dc
Total Power Dissipation @ $T_A = +25^\circ\text{C}$	$P_T(1)$	0.8 W
Total Power Dissipation @ $T_C = +25^\circ\text{C}$	$P_T(2)$	3.0 W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}^{(1)(2)}$	195°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}^{(1)(2)}$	50°C/W
Operating & Storage Temperature Range	$T_J, T_{STG}$	-65°C to +200°C

Notes: (1) For derating, see figure 2 and figure 3 of MIL-PRF-19500/290  
(2) For thermal impedance, see figure 4 and figure 5 of MIL-PRF-19500/290

# 2N2904, 2N2904A, 2N2904AL 2N2905, 2N2905A, 2N2905AL

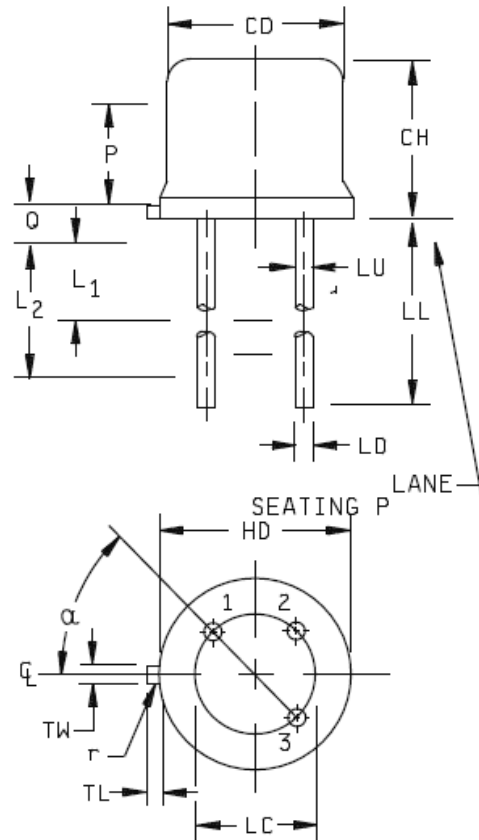


## Radiation Hardened PNP Silicon Switching Transistors

Rev. V3

### Outline Drawing (TO-39)

Symbol	Dimensions				Note
	Inches		Millimeters		
	Min	Max	Min	Max	
CD	.305	.335	7.75	8.51	
CH	.240	.260	6.10	6.60	
HD	.335	.370	8.51	9.40	
LC	.200 TP		5.08 TP		6
LD	.016	.019	0.41	0.48	7, 8
LL	.500	.750	12.70	19.05	7, 8, 12
LU	.016	.019	0.41	0.48	7, 8
L1		.050		1.27	7, 8
L2	.250		6.35		7, 8
P	.100		2.54		
Q		.050		1.27	5
TL	.029	.045	0.74	1.14	4
TW	.028	.034	0.71	0.86	3
r		.010		0.25	10
$\alpha$	45° TP		45° TP		6



#### NOTES:

1. Dimension are in inches.
2. Millimeters are given for general information only.
3. Beyond r (radius) maximum, TW shall be held for a minimum length of .011 inch (0.28 mm).
4. Dimension TL measured from maximum HD.
5. Body contour optional within zone defined by HD, CD, and Q.
6. Leads at gauge plane .054 +.001, -.000 inch (1.37 +0.03, -0.00 mm) below seating plane shall be within .007 inch (0.18 mm) radius of true position (TP) at maximum material condition (MMC) relative to tab at MMC. The device may be measured by direct methods.
7. Dimension LU applies between L1 and L2. Dimension LD applies between L2 and L minimum. Diameter is uncontrolled in L1 and beyond LL minimum.
8. All three leads.
9. The collector shall be internally connected to the case.
10. Dimension r (radius) applies to both inside corners of tab.
11. In accordance with ASME Y14.5M, diameters are equivalent to  $\phi x$  symbology.
12. For "L" suffix devices, dimension LL is 1.50 (38.10 mm) minimum, 1.75 (44.45 mm) maximum.
13. Lead 1 = emitter, lead 2 = base, lead 3 = collector.

FIGURE 1. Physical dimensions (similar to TO-39).

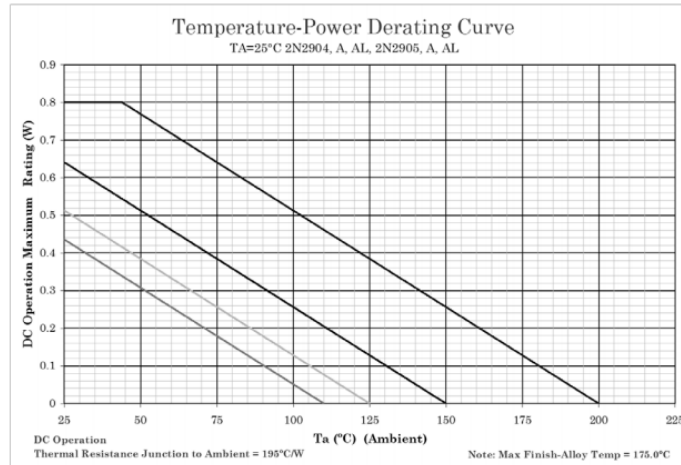
# 2N2904, 2N2904A, 2N2904AL 2N2905, 2N2905A, 2N2905AL



## Radiation Hardened PNP Silicon Switching Transistors

Rev. V3

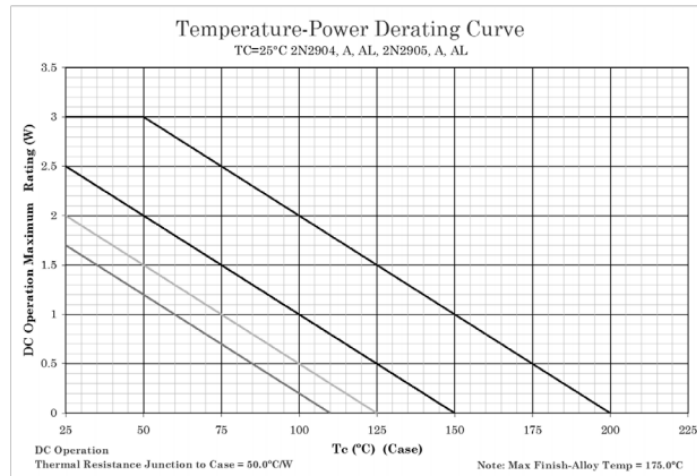
### Temperature-Power Derating Curves



**NOTES:**

1. All devices are capable of operating at  $\leq T_J$  specified on this curve. Any parallel line to this curve will intersect the appropriate power for the desired maximum  $T_J$  allowed.
2. Derate design curve constrained by the maximum junction temperature ( $T_J \leq 200^\circ\text{C}$ ) and power rating specified. (See 1.3 herein.)
3. Derate design curve chosen at  $T_J \leq 150^\circ\text{C}$ , where the maximum temperature of electrical test is performed.
4. Derate design curves chosen at  $T_J \leq 125^\circ\text{C}$ , and  $110^\circ\text{C}$  to show power rating where most users want to limit  $T_J$  in their application.

FIGURE 2. Derating for 2N2904, 2N2904A, 2N2904AL, 2N2905, 2N2905A, 2N2905AL, ( $R_{\theta JA}$ ) PCB (TO-39).



**NOTES:**

1. All devices are capable of operating at  $\leq T_J$  specified on this curve. Any parallel line to this curve will intersect the appropriate power for the desired maximum  $T_J$  allowed.
2. Derate design curve constrained by the maximum junction temperature ( $T_J \leq 200^\circ\text{C}$ ) and power rating specified. (See 1.3 herein.)
3. Derate design curve chosen at  $T_J \leq 150^\circ\text{C}$ , where the maximum temperature of electrical test is performed.
4. Derate design curves chosen at  $T_J \leq 125^\circ\text{C}$ , and  $110^\circ\text{C}$  to show power rating where most users want to limit  $T_J$  in their application.

FIGURE 3. Derating for 2N2904, 2N2904A, 2N2904AL, 2N2905, 2N2905A, 2N2905AL, ( $R_{\theta JC}$ ) PCB (TO-39).

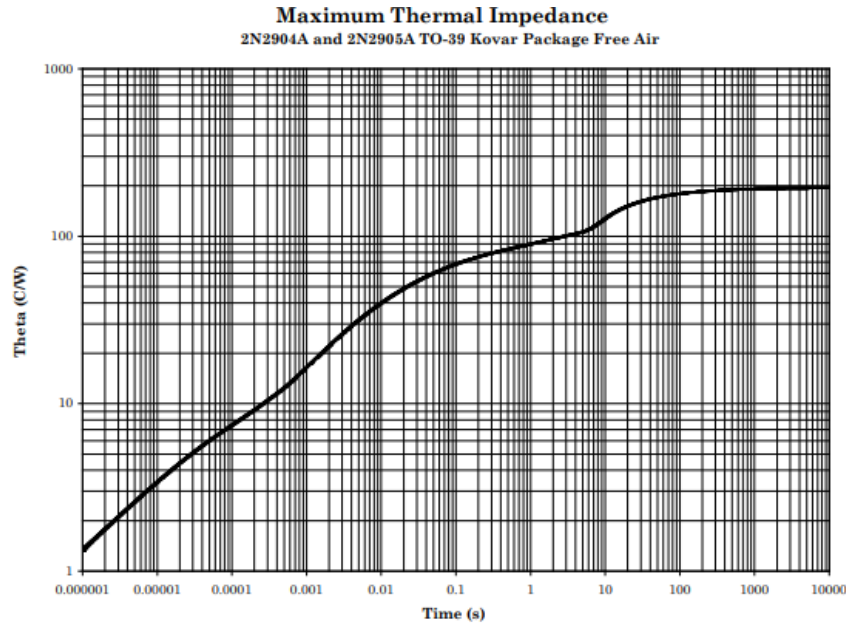
# 2N2904, 2N2904A, 2N2904AL 2N2905, 2N2905A, 2N2905AL



## Radiation Hardened PNP Silicon Switching Transistors

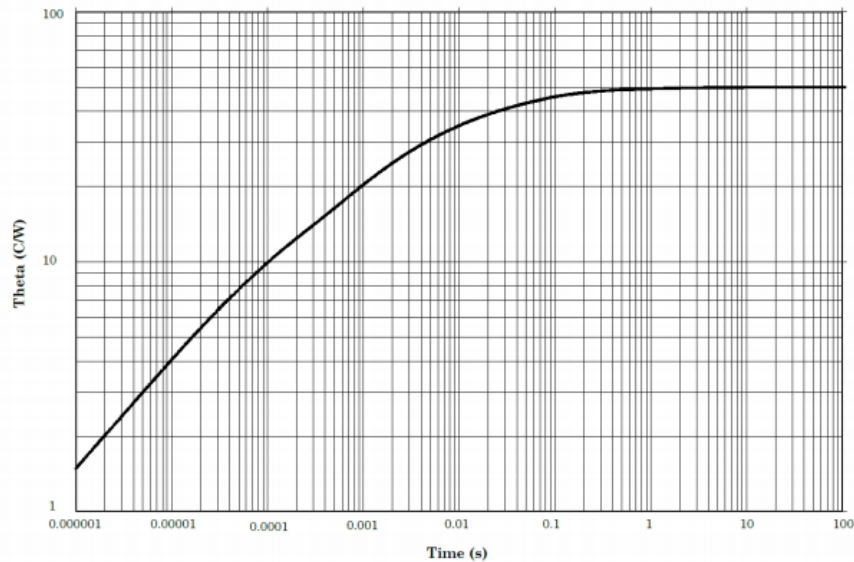
Rev. V3

### Thermal Impedance Curves



Ambient free air cooled  $T_A = +25^{\circ}\text{C}$ , 800mW, thermal resistance  $R_{\theta JA} = 195^{\circ}\text{C/W}$ .

FIGURE 4. Thermal impedance graph ( $R_{\theta JA}$ ) for all 2N2904, and 2N2905 devices (TO-39).



Ambient case mounted  $T_C = +25^{\circ}\text{C}$ , thermal resistance  $R_{\theta JC} = 50^{\circ}\text{C/W}$ .

FIGURE 5. Thermal impedance graph ( $R_{\theta JC}$ ) for all 2N2904, and 2N2905 devices (TO-39).

# 2N2904, 2N2904A, 2N2904AL 2N2905, 2N2905A, 2N2905AL



## Radiation Hardened PNP Silicon Switching Transistors

Rev. V3

**VPT COMPONENTS. ALL RIGHTS RESERVED.**

Information in this document is provided in connection with VPT Components products. These materials are provided by VPT Components as a service to its customers and may be used for informational purposes only. Except as provided in VPT Components Terms and Conditions of Sale for such products or in any separate agreement related to this document, VPT Components assumes no liability whatsoever. VPT Components assumes no responsibility for errors or omissions in these materials. VPT Components may make changes to specifications and product descriptions at any time, without notice. VPT Components makes no commitment to update the information and shall have no responsibility whatsoever for conflicts or incompatibilities arising from future changes to its specifications and product descriptions. No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted by this document.

THESE MATERIALS ARE PROVIDED "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, RELATING TO SALE AND/OR USE OF VPT COMPONENTS PRODUCTS INCLUDING LIABILITY OR WARRANTIES RELATING TO FITNESS FOR A PARTICULAR PURPOSE, CONSEQUENTIAL OR INCIDENTAL DAMAGES, MERCHANTABILITY, OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT. VPT COMPONENTS FURTHER DOES NOT WARRANT THE ACCURACY OR COMPLETENESS OF THE INFORMATION, TEXT, GRAPHICS OR OTHER ITEMS CONTAINED WITHIN THESE MATERIALS. VPT COMPONENTS SHALL NOT BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, INCLUDING WITHOUT LIMITATION, LOST REVENUES OR LOST PROFITS, WHICH MAY RESULT FROM THE USE OF THESE MATERIALS.

VPT Components products are not intended for use in medical, lifesaving or life sustaining applications. VPT Components customers using or selling VPT Components products for use in such applications do so at their own risk and agree to fully indemnify VPT Components for any damages resulting from such improper use or sale.